Modelling of mega-nourishments

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Introduction

The Sand Engine is a hook-shaped mega-nourishment (21.5 Mm^3) located in the Dutch coast with an alongshore length of 2.4 km and an offshore extension of 1 km. The mega-nourishment project was initiated as a coastal protection measure on decadal time scales to maintain the coastline under predicted sea level rise (Stive et al., 2013).

In the present work we use the Q2Dmorfo model (van den Berg, et al., 2012) to predict the dynamics of idealized mega-nourishments, after validation of the model against the evolution of the Sand Engine (Figure 1). The Q2Dmorfo lies between the 2DH models and the one-line models. In particular, it computes the longshore transport in a parameterized way (ignoring the surfzone dynamics) and the cross-shore transport by relaxing the bathymetry to a certain equilibrium. In this way the limitation of the 2DH models related to computational costs is overcomed.

Methods

We first model a series of mega-nourishments following an initial Gaussian shape with distinct synthetic wave climates, this shape assumption is feasible and agrees with the evolution of the initially hook-shaped Sand Engine to a Gaussian shape. We then compare the prediction of the Q2D-morfo model to the one-line theory. For this, we derive an analytic solution of the diffusion equation following the assumption of a shoreline with a Gaussian shape.

Results and Discussion

The analytic solution presents two important limitations: there is no migration and the sand diffused towards the sides is the same (feeding capacity). The one-line approach over-estimates the diffusivity but can be corrected with a factor derived from the Q2D-morfo simulations. The feeding to the adjacent coasts predicted by the Q2D-morfo presents asymmetry related to the dominant wave angles and shows a strong dependency on the initial shoreline angles. The complete analysis will be shown at the conference.

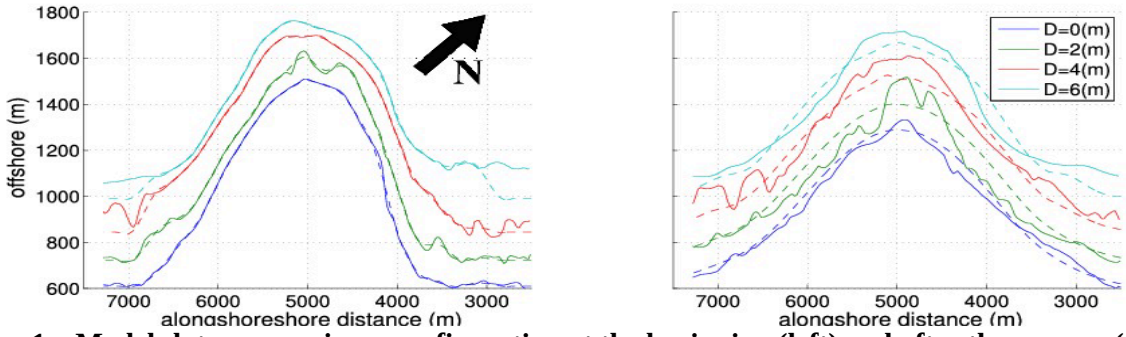

Figure 1 – Model-data comparison: configuration at the beginning (left) and after three years (right), with surveyed (solid) and modeled (dashed) contours. Ratio x-y axis = 1:3. Global shoreline at 600 m.

References

Stive, et al., 2006. Swash-groundwater interaction on a steep gravel beach. Journal of Coastal Research, 29, 1001 - 1008.

Van Den Berg, N., Falques, A. and Ribas, F., 2012. Modeling large scale shoreline sand waves under oblique wave incidene. Journal of Geophysical Research, 117 (F03019).